REMARKS

The Office Action of July 11 29, 2003 has been received and its contents carefully considered.

Claims 1 to 5 and 13 to 16 are all the claims pending in the application, before the present amendment.

The Examiner has not acknowledged applicants' claim for domestic priority to a provisional application. Applicants have previously requested and now again request the Examiner to acknowledge the claim for benefit of the provisional application.

The Examiner has withdrawn the previous rejection of claims 11 to 14 based on Kambe et al, but has entered five new rejections of the claims over five newly cited references.

In each of these rejections, the Examiner takes the position that each reference discloses a high temperature treatment of a carbon fiber at a temperature of more than 2,000C, and that each of these references, therefore, inherently would obtain a carbon fiber having less than 100 ppm of a metal element.

The Examiner asserts that since the present invention achieves the obtaining of a carbon fiber with 100 ppm or less of a metal element by a high temperature heat treatment of approximately 2,000 to 3300C, and since each of the references also teach such a heat treatment, each of these references inherently and necessarily would obtain a purified product as in the present invention.

Applicants discuss each rejection below.

Claims 13-16 have been rejected under 35 U.S.C. § 102(b) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over Kyotani et al.

Applicants submit that Kyotani et al do not disclose or render obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

As set forth in claim 13 as amended above, the present invention is directed to a graphitized carbon fiber obtained by a high temperature heat treatment method for vapor grown carbon fiber which has been produced through thermal decomposition reaction of a carbon source and a transition metal catalyst, serving as main raw materials, which method comprises vaporizing a metal impurity contained in the carbon fiber, and discharging to outside of a heat treatment furnace the impurity through a vicinity of a highest-temperature section of the furnace while being accompanied by a carrier gas, wherein the obtained carbon fiber comprises about 100 ppm or less of a metal element selected from the group consisting of Fe, Ni, Co, Cu, Mo, Ti, V and Pd.

Thus, applicants have amended claim 13 to recite that the present invention is directed to a graphitized carbon fiber obtained by a high temperature heat method for vapor grown carbon fiber, wherein a metal impurity contained in the carbon fiber is vaporized. Claim 13 has also been amended to recite that the impurity is discharged in the vicinity of the highest-temperature section of the heat treatment furnace. Support for these amendments can be found, for example, at page 8, lines 27 to 31, page 9, lines 14 to 19, and the Examples.

Applicants have cancelled claim 14 which was substantially the same as claim 13.

The carbon fibers of claim 13 of the present invention differ from conventional carbon fibers described at page 2 of the specification in that the carbon fiber of the present invention is, as described, for example, in Example 1, a carbon fiber having, for example, an Fe amount of 30 mass ppm (that is, about 100 ppm or less of a metal element) obtained after removing impurities from the gas outlet 25 positioned in the vicinity of the highest-temperature section in the furnace of an apparatus shown in Fig. 4, whereas conventional carbon fibers are a carbon fiber having an Fe amount of, for example, 200 mass ppm, as shown in Comparative Example 1 of the present specification, after removing impurities from the gas outlet 5 positioned at the low-temperature end in the furnace of the apparatus shown in Fig. 2. The heat treatment temperatures that were employed in Example 1 and Comparative Example 1 were the same, namely, 2800°C. This difference in the carbon fibers seems to be attributable to the difference in the temperature distribution inside the heat-treatment furnace where the temperature is higher in the center portion as compared with the vicinity of the inlet of the heat-treatment furnace, and as a result, in the present invention impurities (metal components) can be efficiently discharged without being solidified. See page 9, lines 14 to 30 of the present specification.

Furthermore, in the removal of metal impurities according to the present invention, the percentage removal increases as the heat-treatment time (in the furnace) and the flow rate of carrier gas increase. Therefore, parameters such as heat treatment time and carrier gas flow rate may be determined by taking account of the required impurity standard for the vapor grown carbon fiber. See page 10, lines 2 to 6 of the present specification.

The Kyotani et al article discloses a carbon nanotube obtained by a method of using a template, but not using a transition metal as the catalyst. The obtained carbon nanotube comprises a single hollow tube, with both ends being opened. As described at page 2112, right column, lines 5 to 12, the d_{002} values of the carbon tubes described in Kyotani et al are 0.352 for carbon tubes having a 30 nm diameter or 0.354 nm for carbon tubes having a 230 nm diameter. These values are fairly larger than the theoretical value of graphite, that is, d_{002}=0.3354 nm, and reveal that the carbon tubes in Kyotani et al have low crystallinity. The SAD pattern of the carbon tubes prepared from an anodic oxide film with 230 nm channels after heat treatment at 2,800°C is shown in Fig. 9. However, Kyotani et al are silent on what degree of crystallinity this carbon tube shows. Further, Kyotani et al do not describe the amount of impurities.

In view of the above, applicants submit that Kyotani et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

Claims 13-15 have been rejected under 35 U.S.C. § 102(b) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over Tamura et al.

Applicants submit that Tamura et al do not disclose or render obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

The Tamura et al patent discloses a carbon fiber that has an amorphous core, as shown in Fig. 2 and described at column 9, lines 15 to 33. This structure differs from the vapor grown carbon fiber obtained by pyrolyzing a mixture of benzene and hydrogen according to the method of Koyama referred to in column 1, lines 46 to 50 of Tamura et al.

As described at column 3, lines 51 to 68 of Tamura et al, impurities (Fe, etc.) of a graphite material are purified to 80 ppm or less. However, this graphite material of Tamura et al is not carbon fiber, but comes under the grafoil GTA 5 of Fig. 1. See column 2, lines 51 to 56 and Example 1 of Tamura et al. Tamura et al disclose that by treating this graphite material in a plasma at a high temperature, hair-like carbon filaments are grown as in Example 1. However, the purity of this carbon filament is not shown, and the degree of impurities such as Fe is neither described nor suggested by Tamura et al.

Tamura et al disclose carbon fibers made from a graphite material having an impurity amount of 80 ppm or less, but these carbon fibers do not have a hollow core, and differ from the vapor grown carbon fiber of the present invention.

In view of the above, applicants submit that Tamura et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

Claims 13-16 have been rejected under 35 U.S.C. § 102(e) as anticipated by, or in the alternative under 35 U.S.C. § 103(a) as obvious over Tennent et al.

Applicants submit that Tennent et al do not disclose or render obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

The carbon fiber used in Tennent et al is, as described in claim 1 of Tennent et al, a carbon fiber substantially free of pyrolytically deposited thermal carbon and does not require a heat treatment (graphitization treatment) at 2,500 to 3,000°C, which is necessary in the case of a vapor grown carbon fiber referred to as a related art. See, column 2, lines 32 to 52 of Tennent et al. Accordingly, Tennent et al neither describe nor suggest a high-temperature heat treatment for

removing catalyst metal impurities. Tennent et al disclose a hollow tube, but do not disclose or suggest the amount of impurities.

In view of the above, applicants submit that Tennent et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

Claims 13-15 have been rejected under 35 U.S.C. § 102(e) as being anticipated by, or in the alternative under 35 U.S.C. § 103(a) as obvious over Hiraoka et al.

Applicants submit that Hiraoka et al do not disclose or render obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

Hiraoka et al disclose a carbon fiber which is, as described in column 2, lines 38 to 44 and column 3, lines 47 to 48, polyacrylonitrile (PAN), rayon or pitch carbon fibers, and is not a vapor grown carbon fiber. A vapor phase carbon fiber has, as is known in the art, a hollow core, but a PAN or pitch carbon fiber does not have a hollow core. By heat-treating the PAN or pitch carbon fiber in a halogen gas atmosphere, metal impurities are removed as halides, as disclosed at column 3, lines 59 to 67 of Hiraoka et al, and the impurities are 100 ppm or less in ash content as described in claim 2 of Hiraoka et al. The carbon fiber used in Hiraoka et al, however, is not a vapor grown carbon fiber, and differs from the vapor grown carbon fiber of the present invention.

In view of the above, applicants submit that Hiraoka et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

Claims 13-16 have been rejected under 35 U.S.C. § 102(b) as anticipated by, or in the alternative, under 35 U.S.C. § 102(a) as obvious over Harada et al.

Applicants submit that Harada et al do not disclose or render obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

Harada et al describe, in claim 1, a vapor grown and graphitized carbon fiber having a spin density of $8x10^{18}$ spins/g or less as measured by the electron spin resonance absorption method. This spin density value does not mean the amount of metal impurities, but as described in column 5, lines 44 to 49, this corresponds to the amount of oxygen radical with a g value of 2.015.

In Harada et al, the reason for bringing about a decrease in the oxygen radical shown by the decrease of spin density is described in column 7, lines 14 to 28. The vapor grown carbon fiber of Harada et al is specified by the oxygen radical amount. However, Harada et al do not describe or suggest the amount of metal impurities.

Harada et al disclose performing a heat-treatment (graphitization) at 2000°C or more. However, Harada et al neither suggest nor teach how the impurities are removed, and how a vapor grown carbon fiber reduced in metal impurities can be obtained. By mere heat treatment at a high temperature, the amount of metal impurities does not decrease to 100 ppm or less, as proved in the Comparative Example of the present specification. See page 13, lines 5 to 6 of the present specification, which shows that a heat treatment at 2800°C in a conventional furnace, instead of the 2800°C heat treatment in Example 1 of the present specification, resulted in an Fe impurity amount of 200 ppm as compared to the 30 ppm impurity amount in Example 1.

In view of the above, applicants submit that Harada et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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